allowing non-invasive assessment of the impact optical changes on vision. In particular, we studied the effect of correcting the eye's ocular aberrations, and of inducing high order aberration and phase patterns representing astigmatic or presbyopic corrections (i.e. contact lenses or intraocular lenses) on visual acuity, contrast sensitivity and perceived visual quality. We found that different corrections alter the eye's optical profile, and impact visual performance. For example, refractive surgery decreases the MTF and the CSF, and correcting optical aberrations increased decimal acuity, CSF, and improved performance of certain visual tasks (i.e. face recognition). However, the perceived best focus is altered by prior visual experience, indicating that the eye is adapted to its aberrations, and vision is not only limited by optical degradation but also by the calibration to its internal blur code.

S3.02 **Adaptation to Retinal Blur.**

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The human visual system is continuously adjusting to changes in the environment and within the observer to maintain a constant visual perception. Adaptation processes recalibrate so that how the world looks depend on the recent and long-term visual experience, as every subject is chronically exposed to a different pattern of retinal blur. A series of psychophysical experiments were performed to investigate whether subjects are naturally adapted to their own level of retinal blur, (2) extract the orientation features of the internally coded blur and (3) test whether the internal code for blur is similar between eyes despite interocular differences. To guarantee that all subjects were exposed to a controlled retinal blur, computationally blurred images with known blur pattern were projected through a custom adaptive optics system and all the measurements were performed monocularly under full correction of subject's own retinal blur. Judgments of perceived blur were measured to determine the physical blur level that appeared best focused and oriented blur producing best perceived image quality were measured using a "Classification Image" inspired method. We found (1) a strong correlation between the blur of the best perceived image and the retinal blur produced by the subjects own ocular aberrations, (2) while there is some bias for in favour of individual blur orientation, subjects reveal relatively high tolerance to blur produced by different oriented blur and (3) the best perceived focus matched the retinal blur produced by the least aberrated eye. Adaptive Optics is an effective tool for testing visual perception under controlled retinal blur. The results strongly suggest that vision is adapted to the overall amount of retinal blur, calibration mechanisms for normalizing retinal blur operate to a lesser extent using orientation cues, and a cyclopean mechanism is used to compensate for interocular differences in retinal blur.

S3.03 **Visual Impact of the Chromatic aberrations of the eye.**

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The eye is an optical instrument that project scenes of the visual world onto the retina. However the human eye is far from being a perfect optical system, and, as a consequence, the images projected on the retina are blurred by ocular aberrations, as well as diffraction and scattering. In natural, polychromatic light, the retinal image is affected by interactions among longitudinal chromatic aberration , wave aberrations and transverse chromatic aberration (TCA). In addition optical and structural properties of the eye change with age and with certain ocular conditions and treatments, altering the natural aberrations, as well as the interactions between monochromatic and chromatic aberrations, and consequently the visual function. In the last years, multiple technologies, based on wavefront sensing and Adaptive Optics (AO), have been developed for the measurement and correction of ocular aberrations. Therefore, visual simulators based on AO, incorporating a psychophysical channel, are essential to understand the visual impact of the chromatic aberrations of the eye, the interactions of these aberrations and their effect upon. A series of experiments allowed us to measure in vivo for the first time (1) the longitudinal chromatic aberration (LCA) of the normal eye using objective and subjective techniques in the same subjects in a wide spectral range, with

control of subjects' natural aberrations, (2) the in vivo LCA of pseudophakic subjects implanted with different designs and materials IOLs, and (3) the interactions between LCA and TCA of the human eye. Moreover AO has allowed us to study how the visual system is neurally adapted to the interactions between monochromatic and chromatic aberrations, and how vision is affected by them. In fact, imperfect optics may be the eye's protection against chromatic blur.

S3.04 **Visual simulators and programmable blur.**

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With presbyopia, the eye is no longer able to accommodate and loses the ability to focus at near objects. Ophthalmic corrections for presbyopia attempt to restore functional vision at all distances. Some presbyopic corrections implemented in the form of contact lenses and intraocular lenses provide the patients with new visual experiences in which sharpness has to coexist with blur. In monovision one eye is corrected for far and the other for near, producing an important interocular blur. In simultaneous vision, a multifocal image is created in the retina by combining sharp and blurred image components from different foci. It is not easy to predict the acceptance to these corrections in all cases. We have developed several programmable visual simulators based on optical manipulations to simulate the visual experience of presbyopic corrections. The visual simulators have been used in psychophysical experiments with observers and patients performing different visual tasks (through-focus visual acuity, image scoring, pairwise preferences between corrections, Multifocal Acceptance Score). The simulated multifocal lenses have been validated by direct comparison with real multifocal lenses projected onto the eye, fitted or surgically implanted. Subjects / patients are very consistent in their perceptual responses (STD in perceptual score less than 1 perceptual point in a 0-10 scale; preferences statistically significant across repetitions). This high intra-subject repeatability contrasts with significant inter-subject differences found in the perceptual responses to multifocallity. Visual simulators are a useful tool to include perceptual aspects in the design of presbyopic corrections and to help patients and practitioners choose the best correction according to the visual experience provided. The capability to generate programmable blur also make visual simulators suitable for fundamental research in blur perception.

T3.05 **Chromatic Structure of Graffiti.**

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The colours of traditional paintings have a specific structure that in general mimics the chromatic structure of natural scenes . Urban artists make extensive use of colours, especially when expressing in graffiti. Their colours have not been quantitatively characterized and it is unknown whether they follow the same structure as more traditional paintings. The goal was to characterize the colours of graffiti and to compare to that of traditional paintings. Photos of 228 graffiti of the city of Sao Paulo, Brazil, were taken in five different zones of the city with a Nikon d7000DSLR camera with a CMOS sensor of 16MB resolution (3264×4928 pixels). A X-Rite Macbeth ColorChecker Classic was included in each photo for calibration. The illumination on the colour chart was measured immediately before the photo with a portable spectro-colorimeter Everfine SPIC-200. The spectral reflectance of each ColorChecker sample was measured with a Minolta CM2600d. These data were used to correct the sRGB data using the Moore-Penrose pseudo-inverse transformation. CIELAB for each pixel were computed from the corrected set of tristimulus values. The colours were characterized by the properties of an ellipse. The distributions of these parameters were then compared with those obtained from spectral imaging data from traditional paintings. It was found that graffiti have chromatic